ACCESSORY CASE FOR WIRELESS ELECTRONIC DEVICE

BACKGROUND

[0001] This relates generally to removable cases for electronic devices and, more particularly, to removable cases for wireless electronic devices.

[0002] Electronic devices often include wireless circuitry. For example, cellular telephones, computers, and other devices often contain antennas for supporting wireless communications with external equipment. Some wireless devices contain loop antennas that allow batteries in the wireless devices to be wirelessly charged.

[0003] Removable cases are sometimes used with electronic devices. Removable cases can provide physical protection for an electronic device and may contain batteries to provide supplemental power, but do not provide significant enhanced functionality.

[0004] It would therefore be desirable to be able to provide improved removable cases for wireless devices.

SUMMARY

[0005] A removable case may have a body that is configured to receive an electronic device. The removable case may include a battery that supplements the battery of the electronic device.

[0006] The removable case may be coupled to the electronic device using wired and wireless paths. These paths may be used to convey power and data between the case and the electronic device.

[0007] The removable case may include circuitry that receives wireless power from external equipment. The circuitry that receives the wireless power may receive wireless power at microwave frequencies. Received power may be supplied to the electronic device through wired and wireless paths.

[0008] The removable case may also include circuitry that wirelessly communicates with external equipment. An array of antennas may be used to support beam steering. The array of antennas may support wireless communications in millimeter wave communications bands such as a communications band at 60 GHz or other extremely high frequency communications bands. The case and electronic device may have respective intermediate frequency antenna structures to allow intermediate frequency signals to be wirelessly conveyed between the case and device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a perspective view of an illustrative electronic device and a mating removable case in accordance with an embodiment.

[0010] FIG. **2** is a schematic diagram of illustrative circuitry for use in an electronic device, removable case, and external equipment in accordance with an embodiment.

[0011] FIG. **3** is a circuit diagram of illustrative circuitry for controlling a phased antenna array to implement functions such as beam steering functions in accordance with an embodiment.

[0012] FIG. **4** is a circuit diagram of illustrative circuitry that may be used in the circuits of FIG. **3** to handle phased antenna array wireless communications signals in accordance with an embodiment.

[0013] FIG. **5** is a circuit diagram of illustrative wireless charging circuitry in accordance with an embodiment.

[0014] FIG. **6** is a side view of an illustrative communications system in which intermediate frequency signals may be wireles sly transmitted between an electronic device and associated accessory case in accordance with an embodiment.

[0015] FIG. **7** is a side view of an illustrative system in which wireless power is transferred from external equipment to an electronic device using wireless charging circuitry in an accessory case in accordance with an embodiment.

DETAILED DESCRIPTION

[0016] Electronic devices may be provided with removable external cases. The removable external cases may contain components that add functionality to the electronic devices such as wireless functions. The wireless functions may include, for example, wireless communications capabilities and wireless power transfer capabilities.

[0017] An illustrative electronic device (device **10**A), a mating removable case (case **10**B), and external wireless equipment **10**C are shown in the exploded perspective view of FIG. **1**. Device **10**A may have a housing (body) such as housing **12**A. Display **14** may be mounted in housing **12**A. Openings may be formed in the front face of device **10**A. For example, openings may be formed in a protective display cover layer for display **14** such as an opening for button **16** and speaker port **18**.

[0018] Electronic device **10**A and mating case **10**B may have any suitable shapes. For example, housing **12**A of electronic device **10**A may have a rectangular shape and case **10**B may have a body (housing) such as body **12**B with a corresponding rectangular recess. Rectangular recess **20** of body **12**B may be configured to receive a rectangular device such as electronic device **10**A of FIG. **1**. Electronic devices and cases of other shapes may be used, if desired. For example, a case may have a folding cover, may have the shape of a sleeve that slides over an electronic device, may be mounted to only one end of an electronic device, or may have other suitable shapes that are configured to mate with an electronic device. Structures such as housing **12**A and body **12**B may be formed from materials such as plastic, glass, metal, other materials, and/or combinations of these materials.

[0019] Device **10**A may have a connector port with a connector such as female connector **130**. Connector **130** may have signal pins and power pins (sometimes referred to as contacts, signal paths, or signal lines). For example, connector **130** may have 5-20 contacts, 16 contacts, 8 contacts, more than 3 contacts, or fewer than 32 contacts. Case **10**B may have a mating connector such as male connector **204**. When device **10** is mounted in case **10**B, connector **204** and connector **130** may be coupled to each other (i.e., the contacts of connector **204** may mate with corresponding contacts in connector **130**). A battery in case **10**B may supply supplemental power to device **10**A by routing power signals to the circuitry of device **10**A through power pins in connectors **204** and **130**. Data and control signals may also be routed between device **10**A and case **10**B using connectors **130** and **204**.

[0020] Connector **204** may be coupled to female connector **206** in case **10**B. When it is desired to use an accessory or other external equipment with device **10**A (see, e.g., external equipment **10**C), an external plug (e.g., a plug on the end of